

CLAIMS

What is claimed is:

1. A method for forming a metallic damascene structure, comprising:
forming a damascene opening to expose a metallic layer in a damascene structure;
exposing the metallic layer to a reducing plasma to at least partly reverse an oxidation injury to the
metallic layer;
applying a cleaning process to the damascene structure; and
forming a metallic plug in the damascene opening, the metallic plug in electrical connection with
the metallic layer.
2. The method according to claim 1, further comprising forming the metallic layer from
copper.
3. The method according to claim 1, further comprising forming the metallic layer from
a metal having an easily reducible oxide.
4. The method according to claim 1, further comprising forming the metallic layer from
at least one metal selected from the group consisting of palladium, platinum, nickel, copper, gold,
silver, and cobalt.
5. The method according to claim 1, further comprising generating the reducing plasma
as a hydrogen plasma.
6. The method according to claim 5, further comprising generating the hydrogen
plasma to include at least one inert gas.
7. The method according to claim 6, further comprising selecting the at least one inert
gas from at least one of argon and nitrogen.

8. The method according to claim 2, wherein the oxidation injury comprises formation of copper oxide.

9. The method according to claim 8, further comprising at least partly reversing the oxidation injury by reducing the copper oxide to copper.

10. The method according to claim 1, further comprising forming the damascene structure as a dual damascene structure.

11. The method according to claim 1, further comprising forming the damascene structure as a triple damascene structure.

12. The method according to claim 1, further comprising forming the damascene structure to include a plurality of damascene levels.

13. The method according to claim 1, wherein exposing the metallic layer to the reducing plasma is carried out in an environment in which forming the damascene opening is carried out.

14. The method according to claim 13, wherein the environment comprises a chamber.

15. The method according to claim 14, further comprising operating the chamber in a substantially vacuum environment.

16. The method according to claim 1, wherein forming the damascene opening and exposing the metallic layer to the reducing plasma are carried out in an environment having less oxygen than ambient air.

17. The method according to claim 1, wherein exposing the metallic layer to the reducing plasma is for about 10 to about 60 seconds.
18. The method according to claim 1, wherein exposing the metallic layer to the reducing plasma is for about 10 to about 30 seconds.
19. The method according to claim 1, further comprising providing the reducing plasma at a pressure of about 100 milliTorr.
20. The method according to claim 1, further comprising forming a diffusion barrier layer over the damascene structure before forming the metallic plug.
21. The method according to claim 20, further comprising forming the diffusion barrier layer to include tungsten-nitride.
22. The method according to claim 1, further comprising conducting the cleaning process as a wet cleaning process.
23. The method according to claim 22, further comprising conducting the wet cleaning process employing aqueous dilute hydrofluoric acid.
24. The method according to claim 1, further comprising forming the metallic plug to comprise the same metal as the metallic layer.
25. The method according to claim 1; further comprising forming the metallic plug to comprise copper.

26. A metallic damascene structure including an at least partly reversed oxidation injury in a metallic layer, the metallic damascene structure formed by a method comprising:
forming a damascene opening to expose the metallic layer in a damascene structure;
exposing the metallic layer to a reducing plasma to at least partly reverse an oxidation injury in the metallic layer;
applying a cleaning process to the damascene structure; and
forming a metallic plug in the damascene opening, the metallic plug in electrical connection with the metallic layer.

27. An electronic device comprising the metallic damascene structure of claim 26.

28. The electronic device of claim 27, wherein the electronic device comprises a memory device or a processor.

29. An electronic system, comprising:
a microprocessor; and
an integrated circuit coupled to the microprocessor, at least one of the microprocessor and integrated circuit comprising a metallic damascene structure including an at least partly reversed oxidation injury in a metallic layer, the metallic damascene structure formed by a method comprising:
forming a damascene opening to expose the metallic layer in a damascene structure;
exposing the metallic layer to a reducing plasma to at least partly reverse an oxidation injury in the metallic layer;
applying a cleaning process to the damascene structure; and
forming a metallic plug in the damascene opening, the metallic plug in electrical connection with the metallic layer.

30. The electronic system of claim 29, wherein the microprocessor and the integrated circuit are integrated on the same chip.

31. A metallic damascene structure formed on a semiconductor substrate, the metallic damascene structure comprising an at least partly reversed oxidation injury in a metallic layer thereof.

32. An electronic device comprising a metallic damascene structure formed on a semiconductor substrate, the metallic damascene structure comprising an at least partly reversed oxidation injury in a metallic layer thereof.

33. An electronic system, comprising:
a microprocessor; and
an integrated circuit coupled to the microprocessor, at least one of the microprocessor and integrated circuit comprising a metallic damascene structure formed on a semiconductor substrate, the metallic damascene structure comprising an at least partly reversed oxidation injury in a metallic layer thereof.